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IMPLEMENTATION OF RAIN WATER HARVEST METHOD ON A FEW HOUSING AREA

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ABSTRACT

With rapid urbanization and the advancement of technology, it causes consumption of natural resources in urban areas and global climate change. The most prominent feature of global climate change is that there are sudden and irregular rains in addition to the dry periods. Irregular and sudden precipitation creates negative results especially on hard and impermeable surfaces. Especially in recent years, scenarios where water resources will be exhausted as a result of drought have to be directed towards the positive side. For this reason, the water resources can be taken under protection by accumulating rain waters that exist today against water shortage in the future. In this study, it was aimed to investigate the potential of using the water used by household residents in several residential areas in the city of Trabzon by using rainwater harvesting method on the roofs. In this context, by calculating the average amount of water used by 120 houses, it was determined how much rainwater collected on the roofs met this amount. In addition, the costs of the rainwater collection system and annual water savings were calculated.

KEYWORDS:
Rainwater harvesting, water saving, water harvesting, water use

INTRODUCTION

Water is among the most essential and indispensable sources of life [1]. There is 2.5% fresh water in the world, 70% of this water is from glaciers and the amount of usable water is only 1% of the world water asset [2]. As stated in the Risk Management Report prepared by the World Economic Form, it is stated that it is among the countries that suffer water scarcity and are at risk. It is expected that water scarcity will increase in the coming years and accordingly, demand for water will not meet our water resources.

With each passing day, countries have started to make their own decisions depending on climate change. Intergovernmental Climate Change Panel (Intergovernmental Panel on Climate Change (IPCC)) according 5th Assessment Report (AR5) if Turkey fails to take measures it is stated that the creation of both global and regional issues [3,4]. According to the report of the European Environment Agency, it is predicted that water scarcity will be withdrawn until 2030 snakes and even if the climate conditions improve, the amount of water that people can use will decrease [5].

For centuries, mankind has used it for different purposes to make use of water, beautify its surroundings and use it for functional purposes [6]. However, today, one of the most important problems of cities due to climate change and global warming is the reduction of water resources and water scarcity that will develop accordingly [7]. As a result of this situation, planners have developed urban water management strategies with sustainable water use targets to protect existing water resources [8,9,10].

Rainwater management, which aims to slow, steer and accumulate uncontrolled rainfall water in cities, is actually a reliable water source for many people today [5]. Collection and storage operations in cities to control rainfall water are described as a rainwater method [11]. In other words, rainwater harvesting is also used for domestic and agricultural purposes by accumulating large amounts of rainwater [12]. The main purpose of the rainwater harvest is to provide reliable economically motivated water supply for the development of underground and surface water [13]. The method is water storage, roof surfaces, streets and squares, underground storage areas and basins 'Green Building Certification Systems' are applied in the world and in Turkey for the use of rainwater in buildings. The basis of this application is an application that encourages the reuse of all resources by under-consumed and re-use of resources based on sustainable design practices. In 1990, the UK began to be evaluated according to BREEM and in 1998 according to the LEED system and the buildings were certified according to these criteria. According to the certification system, there are also classifications for water conservation [14,15].

Within the scope of the study, several residential areas in Trabzon were selected and the amount of rainwater collected as a result of the rains was calculated. The calculated amount of rainwater can be used in other activity needs (such as irrigation, household needs, apartment clean) excluding drinking water for housing. For this purpose, the average

amount of water used by each housing was calculated and multiplied by the number of houses. It has been determined how much of this amount of rainwater is covered.

MATERIALS AND METHODS

Within the scope of the study, several residential areas in Trabzon were selected and the amount of rainwater collected as a result of the rains was calculated. The calculated amount of rainwater can be used in other activity needs (such as irrigation, household needs, apartment clean) excluding drinking water for housing. For this purpose, the average amount of water used each housing was calculated and multiplied by the number of houses. It has been determined how much amount of rainwater is covered.

The main material of this research is the Trabzon Yeşiltepe Site, located in north-east of Turkey in Trabzon city (Figure 1). The site has total roof area for 4 buildings is 2270 m^2, green area within the specified limits is 1630 m^2 and the hard ground area is 1170 m^2.

Climate data from Trabzon province are given in Table 1. According to climate data, the month with the highest average temperature is August, and the lowest temperature is in January. When the rainfall data is examined, the average total rainfall is highest in November at 99.6 mm. The total amount of rainfall per day (1927-2019) was 115.1 mm in 10.07.1992 [16]. Trabzon rainfall data from 1927-2019 at the measurement station data was taken into account and the average annual rainfall amount was 830.6 mm. Trabzon province is located in the Eastern Black Sea Region because of the most rainfall is in the position of this reason European Siberian origin has plant communities grown in humid and cold conditions. The fact that the climate is located in the rainiest region across the province is a very rich region in terms of water resources, and streams fed by rain in all seasons make large streams where they are dumped in the Black Sea [17].

In order to find the amount of rainwater collection, the rainwater harvest method was used in the method of studying. The method is calculated with the following formula [18,19].

Rain water yield = Rca x Ra x P x Fa

Roof Rainwater Quantity (m^3) = Roof area (m^2) * 0.9*0.8*Precipitation quantity (annual, mm)

Rca; Rain collection area: The total roof area.

Ra; Rainfall amount: The total amount of annual rainfall determined by the General Directorate of Meteorology.

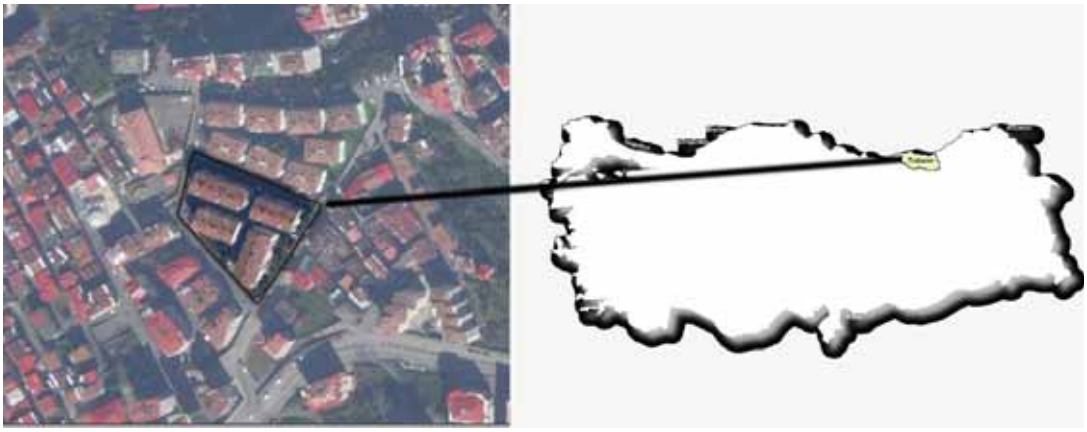


FIGURE 1
The Location of the Study Area- Yeşiltepe Site

TABLE 1
Climate data for study area (1927-2019) [16]

	Jan	Feb	March	Apr	May	June	July	August	Sept	Oct	Nov	Dec
Average temp	7.4	7.2	8.3	11.7	15.8	20.1	22.9	23.3	20.3	16.6	12.9	9.5
Average high temp.	10.7	10.7	11.9	15.5	19.1	23.1	25.9	26.5	23.7	20.0	16.5	12.9
Average low. temp	4.6	4.3	5.4	8.6	12.9	17.0	19.9	20.3	17.3	13.6	10.0	6.7
Average sun duration (hour)	2.6	3.2	3.4	4.3	5.5	7.0	5.9	5.6	4.9	4.5	3.6	2.6
Average precipit. day	11.8	11.7	12.6	12.4	12.3	10.3	7.6	8.3	10.4	11.8	11.3	12.0
Monthly total average (mm)	82.9	64.6	58.4	56.9	52.1	51.8	35.6	48.0	78.6	115.4	99.6	85.7

TABLE 2
Roof area in buildings, water use and rainwater harvest quantity

	Number of households	Roof area (m^2)	Water use (m^3)	Amount of roof rainwater (m^3)	The need for water amount (%)
First building	40	625	1120	377.956	33,74
Second building	20	510	560	304.996	54,46
Third building	20	510	560	304.996	54,46
Fourth building	40	625	1120	377.956	33,74
	120	2270	3360	1.365,904	

P; Penthouse: The coefficient specified by German standards as 0.8 in DIN (1989). The penthouse means that not all rain can be recycled to the roof.

Fa; Filter activity coefficient: The coefficient specified by German standards as 0.9 in DIN (1989). The number of filter activity floors is the efficiency coefficient of the first filter passed to separate rainwater from solids obtained from the roofs.

RESULTS AND DISCUSSION

The total amount of rainwater that can be collected in the roof areas and roof areas for the 4 blocks determined within the scope of the study has been calculated. According to this assessment, the total roof area for 4 buildings is 2270 m^2, green area within the specified limits is 1630 m^2 and the hard ground area is 1170 m^2. On average, 28 m^3 water consumption was determined as the populations of the houses vary accordingly. The total amount of water used for 120 houses is 3,360 m^3 per month.

Table 2 is evaluated in it has a roof 1250 m^2 in the 1st and 4th buildings. 40 households have an average of 1120 m^3 domestic water. There are 20 households in the 2nd and 3rd buildings. These buildings have a roof area of 510 m^2 and a total of 560 m^3 of domestic water is used in 20 households. When calculations were made according to the rainwater harvesting formula, it was determined that 377.956 m^3 of roof rainwater was collected in the 1st and 4th building and 304.996 m3 in the 2nd and 3rd buildings. Similarly, in Sakarya province, where rainwater is high in terms of climate data, Eren et al., (2016) [18] in a study of Sakarya University Esentepe Campus 65824 m^2 roof area for the annual amount of 40379 m^3 roof rainwater was calculated

Given the amount of roof rainwater, it was determined that 40 households in 1st and 4th buildings accounted for 33.74% of the amount of water they needed and 54.46% in buildings 2nd and 3th Dogangönül and Dogangönül (2006) [20] in Konya province, the amount of water used by a family of 4 people with the amount of water used by the roof rainwater amount determined by the 25-ton storage tank with 10-month garden irrigation needs determined.

Rainwater is known to be used for watering green areas in residential gardens, water use in the toilet and washing laundry. There is an application in Germany that came into force in 2003 for the purpose of washing laundry at home. Again, the use of rainwater in a hospital in Germany has been reduced by 20% in the cost of water consumption [21]. Similarly, water use can save between 30-50% using rainwater. Trabzon 2020 According to the list of the unit price of TISKI water m^3 price (mains water) 3.25 TL determined and the average monthly saving amount of water was calculated. According to the calculations, 1,365 m^3 of the consumption of 3360 m3 water is met with rainwater when the rainwater harvest method is applied at Yeşiltepe Site, where 4 buildings are located. It was determined that 120 households saved a total of 4,436.25 TL per month. Kılıç and Abuş (2018) [19] calculated rainwater harvesting in a single residence with a garden over the water price in 2017, calculated that 47% of total consumption could be provided from rainwater and could save 335 TL annually. In the same study, the volume of storage for the collection and accumulation of roof rainwater was calculated. Warehouse volume account; based on the period of maximum rainfall.

Warehouse volume = the amount of precipitation x roof square meter x 0.8 x 0.9.

In its work, it was determined that 14.5 m^3 storage volume is required for a garden edifying. Similarly, when the required warehouse volume was calculated, it was determined that 188.609 m^3 warehouse volume was needed by taking into account 115.4 mm in October, which received the most rainfall.

CONCLUSIONS

Especially due to climate change experienced in recent years, the misuse and unconscious consumption of water resources are scarce. This situation is not today, but when scenarios are created in the coming years, serious measures should be taken. Among the most effective measures identified was to accumulate and reuse rainwater. In this sense, the rainwater management evaluated has started to take its place in the cities. Rainwater harvesting based on rainwater management planning criteria has been used in evolving technology for sustainable use of water resources and water conservation.

Approximately 70% of the water consumed for water use is consumed as a result of garden irrigation,

toilet and laundry purposes. Only 30% of rainwater joins groundwater, and the remaining 70% are directly mixed into the sewers. This study, which is evaluated in this context, has developed an example of rainwater harvesting in several residential areas in Trabzon. Trabzon is actually among the most suitable cities for rainwater harvesting because it is a rainy region. For this purpose, 1,365,904 m^3 roof rainwater amount was calculated in a site area with 120 houses. The total domestic water requirement of the site has been set at 3360 m^3, 1st and 4th are 33.74 % for buildings, 2nd and 3th are 54.46% for buildings. It was determined that 120 households saved a total of 4,436.25 TL per month by rainwater harvesting method in Yeşiltepe Site.

As a result of the study, it was determined that an advantageous water saving of a 120-household site would be provided by rainwater collection method. In these days when water shortages are in tract, both cheap and practical systems such as rainwater harvesting should be expanded. As a city with plenty of rainfall water like Trabzon, these and similar applications can be applied primarily in houses and then in businesses and shopping buildings. Ecological-based urban systems can be developed with the applicability of these systems.

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